CHEMURGY
Servant or Master

By

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The word chemurgy is new, but the idea is old. The primitive hunter who prepared the metal for his bronze and iron weapons performed a chemurgic operation, and the early herdsman who turned milk into cheese was also one of the first chemurgists. Thus, in the literal sense, chemurgy or chemistry at work can be used to include any application of chemistry. Due, however, to the circumstances under which the expression chemurgy was first proposed, the word has come to have a more restricted meaning and is used to describe the industrial utilization of agricultural raw materials. The name is now applied to any operation concerned with the processing of an agricultural raw material to produce a more finished product. From the time of the primitive hunter and herdsman on down to the present, chemurgy in this sense has been outstanding among man's many tools in his march toward a higher standard of living.

However, chemurgy, like all great movements, has within it the seeds of good and evil. It remains for us who are engaged in this work and those who are interested in its continuation to determine the path that chemurgy shall follow, and whether it is to be our master or our servant. If we allow ourselves to be carried away by the romance of the substitution of the farm for the mine and oil well, and neglect the economics of the picture, we shall find ourselves the slaves to an illusion rather than the masters of a great idea. It is only when chemurgy is used intelligently as a tool to search for profitable outlets for agricultural commodities to provide raw materials for industry, and to create new wealth that it becomes our obedient servant. Let us look at some of the sensible applications of chemurgy during the past century.

One of the earliest non-food chemurgic industries in this country began around 1850 when Kingsford started the commercial production of starch from corn. Portions of other crops have been used for industrial purposes from time to time, but no organized effort had been made to promote the use of large quantities of crops in industry until the chemurgic movement, as we know it today, got under way in 1935.

The soybean is often referred to as a good example of a chemurgic crop because it has made such phenomenal progress in such a short time. Since 1904, the production of soybeans has increased from nothing to something like 200,000,000 bushels last year. Soybean products are used today for

making paint, plastics, rubber substitutes, adhesives, shotgun shells, and many other things in the industrial field, as well as for food and feed purposes. It is used for so many things that it is sometimes called the many-sided bean. The price of soybeans before the grain market started skidding a few weeks ago was better than $4 a bushel. At that time the oil alone in a bushel of beans was worth more than $2. But what was it that put the soybean on the enviable throne it enjoys today? It was chemurgic research. When the agronomist, and the chemist, and the engineer teamed up in a coordinated attack on the soybean, the results were so rapid and so satisfactory that they practically amazed the world.

This coordinated attack was the result of a carefully planned and organized soybean research program that included all angles of the soybean industry. The best available chemists and agronomists were employed in the first soybean laboratory which was established at Urbana, Illinois. The cooperating States likewise assigned some of their best men to the soybean work. These men were masters of their trades. Their program included every phase of soybean production and utilization from planting, cultivating, and harvesting to all types of chemical research leading to industrial utilization. The research was well organized and the program was complete. That is why the soybean has succeeded in such a comparatively short time. The soybean industry in this country is unquestionably the result of timely properly organized research.

The soybean grows well over a large portion of the country. In general, it is more resistant to drought and disease than any other major crop. Being easily grown on such a wide variety of soils, the production end of this crop would have undoubtedly run away with the show and might have resulted in troublesome surpluses if we had not used properly organized research to find new uses for the increased production. These new outlets have had a stabilizing effect in balancing the production and utilization of this important crop.

What I have said about the soybean applies in a general way to other crops and to chemurgic projects as a whole. You are all familiar with the old statement that a chain is no stronger than its weakest link. That is certainly true in the chemurgic field. Many promising chemurgic projects have folded up after a short period of favorable publicity because sufficient attention was not given to some of the weak links. It is better for all concerned that we find these weak links and strengthen them before we build the factory. There isn't anything wrong with chemurgy. It is sound. The trouble, if it comes, usually results from overenthusiastic individuals who get the cart before the horse, or who fail to give proper consideration to all parts of the program.

Although it was not called by that name, the first chemurgic conference was held in this country in 1935. That was only 13 years ago. During this comparatively short period the chemurgists have acquainted people in

practically all walks of life with their movement. The romance so frequently attached to a new undertaking has given way to more constructive thinking and the movement is now on a reasonably sound footing. A review of the chemurgic accomplishments shows that steady progress is being made in expanding the industrial outlets for agricultural commodities. All of these accomplishments are the result of the same kind of organized research that is so largely responsible for the successful development of the soybean industry.

Chemurgic research has enabled naval stores, one of the oldest industries in this country, to continue to thrive and to expand its operations under highly competitive conditions. It has aided the wet milling of corn, another old industry, and is playing a large part in the oldest chemurgic industry of all, the production of alcohol and its byproducts. These few outstanding examples illustrate the remarkable success that has attended the intelligent application of chemurgy to agricultural problems.

Let us look now at some of the problems that must be considered in judging the feasibility of the application of chemurgy to an agricultural problem and in carrying the operations through to a successful conclusion. A great many people think that chemurgy means only the manufacturing of agricultural commodities. That's just one phase of it. Real constructive chemurgy means everything that is required to make a commercial success of the undertaking. It means new uses for farm crops as well as new uses for the byproducts of these crops. It means new uses for old crops, and special crops for new uses. It means soil conservation and land utilization. It includes chemistry, engineering, economics, agronomy, banking, business administration, and all of the other things required to make a successful enterprise.

One of the most important problems confronting the chemurgists today is the development of new techniques or methods for the profitable use of surplus crops in years of better than average production. And that's quite a problem, too, because no industry wants to start a business on raw material that is plentiful one year and scarce the next. Take potatoes, for example. After wrestling with the surplus potato problem for a good many years the chemurgists have finally come up with three solutions which look pretty good on the surface but which need further consideration. One of these would make livestock feed from surplus potatoes. Another would turn the surplus potatoes into flour for human consumption. Both have advantages and disadvantages. We seldom have more livestock feed than we need, but it is questionable whether farmers could afford to grow and sell potatoes for making feed. We don't eat potato flour in worthwhile quantities in this country because we are not accustomed to it. But the Europeans like potato flour. So it has been suggested that we manufacture flour from surplus potatoes and ship that flour abroad where it is liked and used, and keep the wheat that we like and are accustomed to for our own consumption. The third solution, of course, is the production of alcohol. I mention this example because it

shows that the chemurgists have to consider many things besides the manufacturing angle. Failure is apt to follow the establishment of new chemurgic enterprises unless sufficient thought is given to all angles of the development from the production of the raw material up to the marketing of the finished product. Industry is in business to make money and is not interested in ideas unless they are productive. The chemurgist, therefore, must prove to all concerned that his idea is sound, that he is familiar with all angles of the development, and, in short, master of the situation.

The Department of Agriculture's four Regional Research Laboratories which are operated by the Bureau of Agricultural and Industrial Chemistry were authorized in 1938, just three years after the chemurgic movement got under way and largely as a result of this movement. They are sometimes spoken of as the chemurgic agency for the Department because they are using chemistry as a tool to search for new and wider outlets and markets for agricultural commodities. The Department had been searching for industrial outlets for farm products in a limited way for 25 or 30 years before the establishment of these laboratories, and had a number of achievements to its credit, but it was a sort of sideline compared with the main agricultural program. The establishment of the laboratories marked the beginning of the Federal Government's entry into the chemurgic field on a large scale and made it possible to attack the surplus problem on a nation-wide basis.

I might say, for the sake of any of you who are not familiar with these laboratories, that one is located in each of the four major farm-producing areas of the country. Peoria, Illinois, is the home of the laboratory for the 12 North Central States. The New Orleans Laboratory serves the South, the one at Philadelphia, Pennsylvania, the East, and one at Albany, near San Francisco, California, the West.

Fortunately these laboratories were completed and staffed in time to aid in wartime research. More than 150 research projects dealing with the use of agricultural commodities in the war were carried on in them. Basing their activities on the results of the Bureau's earlier research, much of it basic in nature, scientists in the Peoria Laboratory which serves Nebraska and the other States in this part of the country, quickly increased the yield of penicillin so that it could be produced on a commercial scale. They did this by feeding the mold that produces penicillin on a new diet composed largely of two simple agricultural byproducts--corn steep liquor, a byproduct obtained in the manufacture of cornstarch, and lactose or milk sugar, a byproduct of the dairy industry. More than one hundred million dollars worth of penicillin is now produced each year. But no money value can be placed on the human lives saved as a result of the large-scale commercial production made possible by the laboratory scientists so soon after our entry into the war. The war is over but penicillin continues to be produced in large quantities, both here and abroad, by methods worked out in the Peoria Laboratory and will continue to serve mankind for years to come. This is one of the ways research benefits humanity.

Chemists in the Philadelphia Laboratory worked out an economical method for the production of apple sirup, which you may have heard called "apple honey," which was used as a substitute for glycerin during the war by one of the large manufacturers of cigarettes.

Scientists in the New Orleans Laboratory produced an improved cotton cord that was built into automobile tires that delivered mileage in official Army Ordnance tests, according to the advertisements of one of the leading tire manufacturers, far superior to any previous cotton-bodied tires ever built.

The services of more than one-third of the entire staff of the California Laboratory were quickly centered on the development of new and improved methods for the dehydration of vegetables so that valuable space could be conserved on badly needed ships which were fighting a losing battle with enemy submarines during the early days of the war.

The statement has been made that the wartime research on penicillin, apple sirup, dehydration, automobile tires, rubber, and other projects has already been worth more to mankind than it will cost to operate the laboratories for the next quarter of a century.

There are several reasons why the Regional Research Laboratories have been successful in their research operations. In the first place the buildings are modern. They were designed and built for a purpose. So many laboratories, particularly the small ones, are akin to what is sometimes called a hole in the wall, and are not always adapted to the kind of work to be performed in them. Scientists in the agricultural field have long felt the need for a method of evaluating their research on a level above the test-tube or laboratory scale. What they wanted and needed were provisions for research on a pilot-plant scale. But pilot-plant research, because of the size of the equipment and cost of operation, is much more expensive than laboratory research and has, therefore, been slow in coming into State and Government-owned agricultural institutions. The people in our Bureau felt that pilot-plant research was so important that approximately one-third of the entire space in each of the four laboratories was set aside for this larger-scale research where semicommercial size machines could be built and operated. We have found that even this is not enough.

Good equipment is an important part of a laboratory, too. The designers of the Regional Laboratories were aware of this and planned for the best equipment that could be had. This was a good move because it provided our scientists with suitable tools for putting their ideas into workable form.

Considerable attention was also given to the staffing of these laboratories. Government salaries, as a rule, are not on a level with those paid by industry. That, naturally, handicaps us to some extent. Some of our scientists leave us after they have been trained for a year or so in a

particular field, and go with industry at better salaries than we can pay. But we can't complain too bitterly about that because these men go into industry and promote the results developed in the laboratories.

You have probably gathered from what I have said that these laboratories were designed, built, equipped, and staffed for a particular job. That is right. And that job was to find new and wider uses for agricultural products in the hope that these accomplishments would increase the cash income of farmers and help to stabilize agricultural production. We are with you on this occasion because all of us are searching for more profitable uses for the things we grow or make. We, in the Bureau of Agricultural and Industrial Chemistry, feel that we have succeeded when industry starts the commercial production of some product based on the results of research in one of our laboratories or when it begins to use one of our techniques, or methods of processing.

I might say that the Regional Research Laboratories were established with the hope that they would make a contribution to the solution of the surplus agricultural problem. They were a challenge to the critics who said surplus crops were acts of Nature and that nothing could be done about them. There was enthusiastic support as well as bitter opposition to the establishment of these laboratories. The accomplishments thus far have been encouraging because we have kept the research on a sound basis. We would have been licked long ago if we had not followed such a course.

The 1947 Annual Report of the Bureau of Agricultural and Industrial Chemistry, which is somewhat technical in nature, and limited in circulation, contains information on 64 projects on which research had advanced during the past year to the point where it was felt that the information should be passed on to the public. New discoveries and new scientific and industrial developments, based on the Bureau's research during the past fiscal year, are described in the Report and in the 289 scientific publications and the 27 public service patents granted during that period.

This Report contains information on the effort being made by our California Laboratory to recover ascorbic acid or Vitamin C from the hulls of English or Persian walnuts. It is believed that there are about 125,000 pounds of recoverable ascorbic acid worth, at present prices, more than one and a half million dollars produced in the hulls of the California walnut crop each year. Our chemists have developed a method for the extraction of this acid in pure crystalline form.

There is information on the production of feed yeast, rich in high-quality protein and in the Vitamin B complex, by growing the yeast on the juice pressed from ground, limed citrus peel and pulp left in the commercial canning operation. A 90-pound box of citrus fruit yields about 3 gallons of press juice which will make 1 pound of dry yeast. It is estimated that the potential production of feed yeast from this source would amount to approximately 30,000 tons a year.

There is an item on the profitable utilization of the millions of tons of vegetable wastes that pile up at canning and other vegetable processing plants from one end of the country to the other. A method has been worked out for the commercial production from this waste material of a leaf meal that compares favorably with alfalfa leaf meal for chicken feed. Chemists found some of these vegetable wastes to be so rich in proteins and valuable vitamins that one authority remarked that it looked as though we were eating the wrong part of the plants.

Persons interested in tung oil will find information on the approximately 11,000,000 pounds of tung oil produced from the last harvest of approximately 67,000 tons of tung fruits or nuts. I might add that it is believed by chemists that tung meal which is slightly toxic can now be made safe and suitable for cattle feed. Tung meal is high in protein.

There is also information on rutin the new drug that is proving beneficial in treating hemorrhage due to high blood pressure. This drug is now in commercial production and available on prescription at most drug stores. This is a new use for an old crop and will require an increase of 64,000 acres of buckwheat to produce sufficient rutin to meet the demand!

War naturally speeds up research and some of our progress can be attributed to the war, but much of it is due to the fact that our leaders have organized their research programs, investigated the various angles of their projects, and supplied the workers with the proper tools for their work, whether it be a test tube or a full-size pilot plant. Another thing that has contributed to the progress that has been made in these laboratories is the fact that in the selection of personnel we have definitely attempted to secure not just chemists or physicists or engineers, but scientists with training or experience in the particular field in which they are to work. That has been very helpful. So has the cooperation we have received from agriculture and industry.

The need for the type of research that is being done in the Regional Research Laboratories is perhaps greater today than ever before because farmers are facing the tremendous problem of adjusting expanded wartime production to peacetime needs. This is particularly true in sections where a large acreage has been devoted to the production of certain crops. New outlets or even slight expansions of present outlets for some of these commodities might aid materially in the conversion program.

There is a growing interest in the production of crops for industrial purposes, and the outlook is more promising in that field now than it was when the laboratories were built. But changes in cropping systems or in methods of production take place rather slowly, and it will probably be a number of years before the growing of crops for industrial use will be in general practice. It will probably develop slowly, over a period of years as the industrial markets are established, and as farmers become acquainted with the production of commodities for that use.

In conclusion, I think you will agree that our discussion today has demonstrated very clearly that during the 13 years that have intervened since the Conference of Agriculture, Industry and Science at Dearborn on May 7, 1935, Chemurgy, the offspring of that conference, has reached maturity. It has been endowed with outstanding leadership in its President, equipped with laboratories and research personnel, and stands on what is only the threshold of the accomplishments which are to be expected in the years that lie ahead. So, in answer to the question as to whether chemurgy is to be our servant or our master, I can only say that that depends on us; but I think that the results of the last few years show very clearly that when chemurgy is properly organized and used in all its many-sided aspects, it will serve us in preparing a bright and useful future for farmer, industrialist, and consumer alike.

We have an exhibit here which contains additional information on our investigations, and attendants who will be glad to answer your questions or help you in any way. I hope you will take advantage of this opportunity to get acquainted with the chemurgic work we are doing.